Recovery Plan for U.S. Population of

Atlantic Green Turtle
Chelonia mydas

U.S. Department of Commerce
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RECOVERY PLAN FOR U.S. POPULATION OF ATLANTIC GREEN TURTLE

(*Chelonia mydas*)

Prepared by

The Loggerhead/Green Turtle Recovery Team

for

Southeast Region

U.S. Fish and Wildlife Service

Atlanta, Georgia

and

National Marine Fisheries Service

Washington, D.C.

Approved: ______________________
Regional Director, U.S. Fish and Wildlife Service

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Approved: ______________________
Assistant Administrator of Fisheries
National Marine Fisheries Service

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Recovery plans delineate reasonable actions which are believed to be required to recover and/or protect the species. Plans are prepared by the U.S. Fish and Wildlife Service and National Marine Fisheries Service and sometimes with the assistance of recovery teams, contractors, state agencies, and others. Objectives will only be attained and funds expended contingent upon appropriations, priorities, and other budgetary constraints. Recovery plans do not necessarily represent the views nor the official positions or approvals of any individuals or agencies, other than the U.S. Fish and Wildlife Service and National Marine Fisheries Service involved in the plan formulation. They represent the official position of the U.S. Fish and Wildlife Service and National Marine Fisheries Service only after they have been signed by the Regional Director and Assistant Administrator of Fisheries as approved. Approved recovery plans are subject to modification as dictated by new findings, changes in species status, and the completion of recovery tasks.

Literature citation should read as follows:

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PREFACE

The original Recovery Plan for Marine Turtles was approved by the Assistant Administrator for Fisheries, National Marine Fisheries Service, September 19, 1984. The plan included the loggerhead (*Caretta caretta*), green turtle (*Chelonia mydas*), hawksbill (*Eretmochelys imbricata*), leatherback (*Dermochelys coriacea*), and Kemp's ridley (*Lepidochelys kempi*).

The U.S. Fish and Wildlife Service and National Marine Fisheries Service share the responsibility for sea turtle recovery under the authority of the Endangered Species Act of 1973, as amended. In an effort to better coordinate a recovery program for sea turtles, both Services recognized the need to reassess present conservation efforts and consider the new biological information available since approval of the original recovery plan. To accomplish this, the Services created a Loggerhead/Green Turtle Recovery Team, Leatherback/Hawksbill Recovery Team and a Kemp's Ridley Recovery Team. The Recovery Teams have developed separate species plans to provide greater focus and emphasize the uniqueness of individual species. This revision was undertaken by the Loggerhead/Green Turtle Recovery Team consisting of the following team members:

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This revised plan incorporates the new format that has become standard in recovery plans in recent years. It is intended to serve as a guide that delineates and schedules those actions believed necessary to restore the Atlantic green turtle as a viable self-sustaining element of its ecosystem. It is recognized that some of the tasks described in the plan are well underway. The inclusion of these ongoing tasks represents an awareness of their importance, and offers support for their continuation.

LIST OF ABBREVIATIONS

ADNR	Alabama Department of Natural Resources
CCAFS	Cape Canaveral Air Force Station
CITES	Convention on International Trade in Endangered Species of Flora and Fauna
COE	U.S. Army Corps of Engineers
CPA	Canaveral Port Authority
CZM	Office of Coastal Zone Management
EPA	U.S. Environmental Protection Agency
FDNR	Florida Department of Natural Resources
FPL	Florida Power and Light Company
FWS	U.S. Fish and Wildlife Service
GDNR	Georgia Department of Natural Resources
IUCN	International Union for the Conservation of Nature
KSC	Kennedy Space Center
LDWF	Louisiana Department of Wildlife and Fisheries
MARPOL	International Convention for the Prevention of Pollution from Ships
MDW	Mississippi Department of Wildlife
MMS	Minerals Management Service
NCDNR	North Carolina Department of Environment, Health and Natural Resources
NMFS	National Marine Fisheries Service
NPS	National Park Service
PRDNR	Puerto Rico Department of Natural Resources
SCWMRD	South Carolina Wildlife and Marine Resources Department
TPW	Texas Parks and Wildlife Department
USAF	United States Air Force
USCG	United States Coast Guard
USMC	United States Marine Corps
USN	United States Navy
VIDFW	Virgin Islands Division of Fish and Wildlife
VIDPNR	Virgin Islands Department of Planning and Natural Resources
VMRC	Virginia Marine Resources Commission

EXECUTIVE SUMMARY

Current status: Breeding populations in Florida and on the Pacific coast of Mexico are federally listed as endangered. All other populations are listed as threatened. Primary nesting beaches occur along a six county area in east central and southeast Florida. Nesting activity ranges from approximately 350-2,300 nests annually. Coastal development threatens nesting habitat and populations while commercial fisheries and pollution pose significant threats in the marine environment.

Goal: The recovery goal is to delist the species in the United States once recovery criteria are met.

Recovery criteria: The U.S. population of green turtles can be considered for delisting if, over a period of 25 years, the following conditions are met:

1) The level of nesting in Florida has increased to an average of 5,000 nests per year for at least 6 years.

2) At least 25 percent (105 km) of all available nesting beaches (420 km) is in public ownership and encompasses greater than 50 percent of the nesting activity.

3) A reduction in stage class mortality is reflected in higher counts of individuals on foraging grounds.

4) All priority one tasks have been successfully implemented.

Actions needed: Six major actions are needed to achieve recovery.

1. Provide long-term protection to important nesting beaches.

2. Ensure at least 60 percent hatch success on major nesting beaches.

3. Implement effective lighting ordinances or lighting plans on nesting beaches.

4. Determine distribution and seasonal movements for all life stages in marine environment.

5. Minimize mortality from commercial fisheries.

6. Reduce threat to population and foraging habitat from marine pollution.

Date of recovery: If funds are available to accomplish recovery tasks and new information does not indicate other limiting factors, the anticipated date of recovery is 2015.

***Total cost of recovery:**

Land acquisition:	$90,000,000
Actions on nesting beaches	9,800,000
Actions in marine environment	54,000,000

*$145,700,000 of these costs are shared with actions identified in the Loggerhead Recovery Plan.

PART I. INTRODUCTION

Taxonomy: The green turtle was described by Linnaeus in 1758 as *Testudo mydas* with Ascension Island as the type locality. Schweigger first applied the binomial we use today, *Chelonia mydas*, in 1812. The taxonomic status of the green turtle is not clear. There is believed to be little genetic exchange among isolated breeding colonies, and, thus, these colonies may deserve sub-specific recognition. Although trinomials have been applied to various populations in the past, they are generally not in use today. Advances in DNA research may help solve these taxonomic questions by identifying genetically isolated populations. For a complete discussion of the systematics of green turtles see Pritchard and Trebbau (1984) and Hirth (1980a).

Description: The green turtle is the largest thecate sea turtle; adults commonly reach a meter in carapace length and 150 kg in mass. The mean size of female green turtles nesting in Florida is 101.5 cm (n = 90, SD = 5.8) standard straight carapace length and 136.1 kg (n = 15, SD = 17.7) body mass (Witherington and Ehrhart, 1989). Characters that distinguish the green turtle from other marine turtle species are a smooth carapace with four pairs of lateral (or costal) scutes and a single pair of elongated prefrontal scales between the eyes. Hatchling green turtles weigh approximately 25 g, and the carapace is about 50 mm long. The dorsal surface is black, and the ventral surface is white. The plastron of Atlantic green turtles remains a yellowish white throughout life, but the carapace changes in color from solid black to a variety of shades of grey, green, brown and black in starburst or irregular patterns.

Population Distribution and Size: The green turtle is a circumglobal species in tropical and sub-tropical waters. The worldwide distribution of green turtles has been described by Groombridge (1982). In U.S. Atlantic waters, green turtles are found around the U.S. Virgin Islands, Puerto Rico, and continental United States from Texas to Massachusetts. Areas that are known as important feeding areas for green turtles in Florida include Indian River Lagoon, Florida Keys, Florida Bay, Homosassa, Crystal River and Cedar Key. In the past, green turtles were fished commercially in all of these areas. There was also a commercial fishery for green turtles in Texas at the end of the last century; most of the turtles were from Aransas Bay, Matagorda Bay and Laguna Madre (Hildebrand, 1982; Doughty, 1984).

Major green turtle nesting colonies in the Atlantic occur on Ascension Island, Aves Island, Costa Rica and Suriname. In United States Atlantic waters, green turtles nest in small numbers in the United States Virgin Islands and in Puerto Rico, and in larger numbers along the east coast of Florida, particularly in Brevard, Indian River, St. Lucie, Martin, Palm Beach and Broward Counties. The number of egg clutches deposited by green turtles in Florida was 736 in 1985, 350 in 1986, 866 in 1987, 466 in 1988, 559 in 1989, and 2288 in 1990 (Conley and Hoffman, 1986; FDNR, unpubl. data). It is not possible to assess trends in the nesting population from these data because the length of beach surveyed varied among years. Statewide, a total of 616 km, 823 km, 971 km, 982 km and 1011 km, was surveyed in 1986, 1987, 1988, 1989, and 1990, respectively (FDNR, unpubl. data). More information is needed before detailed distribution maps or estimates of population number and structure can be made for green turtle populations in United States territorial waters.

Status: The green turtle is listed as Endangered by the International Union for the Conservation of Nature (IUCN) (Groombridge, 1982) and is listed on Appendix I of the Convention on International Trade in Endangered Species of Flora and Fauna (CITES). In 1978, under the United States Endangered Species Act of 1973, the green turtle was listed as Threatened except for the breeding populations in Florida and on the Pacific coast of Mexico, which were listed as Endangered. Green turtles continue to be heavily exploited by man, and degradation of nesting and feeding habitats are serious problems. Overexploitation by man has already caused the extinction of large green turtle populations including those that once nested on Bermuda and Cayman Islands. The status of green turtle populations are difficult to determine because of the long generation time and inaccessibility of the early life stages. The number of nests deposited in Florida appears to be increasing, but whether this upward trend is due to an increase in the number of nests or is a result of more thorough monitoring of the nesting beaches is uncertain.

Biological Characteristics: Several excellent reviews of the biological characteristics of green turtles have been published in recent years (Hirth, 1980a; Groombridge, 1982; Ogren, 1984; Pritchard and Trebbau, 1984; Ehrhart and Witherington, in prep). The discussion here will be brief; the reader is referred to these reviews for more detail.

Habitat: Green turtles occupy three habitat types: high-energy oceanic beaches, convergence zones in the pelagic habitat, and benthic feeding grounds in relatively shallow, protected waters. Females deposit egg clutches on high energy beaches, usually on islands, where a deep nest cavity can be dug above high water line. Hatchlings leave the beach and apparently move into convergence zones in the open ocean where they spend an undetermined length of time (Carr, 1986). When turtles reach a carapace length of approximately 20 to 25 cm, they leave the pelagic habitat and enter benthic feeding grounds. Most commonly these foraging habitats are pastures of seagrasses and/or algae, but small green turtles can also be found over coral reefs, worm reefs and rocky bottoms. Some feeding grounds only support certain size classes of green turtles; the turtles apparently move among these foraging areas--called developmental feeding grounds--as they grow. Other feeding areas, such as Miskito Cays, Nicaragua, support a complete size range of green turtles from 20 cm to breeding adults. Coral reefs or rocky outcrops near feeding pastures are often used as resting areas, both at night and during the day.

Diet: It is assumed that post-hatchling, pelagic-stage green turtles are omnivorous, but there are no data on diet from this age class. It is known that once green turtles shift to benthic feeding grounds they are herbivores. They feed on both seagrasses and algae. Information on diet and nutrition of green turtles has been reviewed (Mortimer, 1982a; Bjorndal, 1985).

Growth: Growth rates of pelagic-stage green turtles have not been measured under natural conditions. However, growth rates of green turtles have been measured on the benthic feeding grounds. Green turtles grow slowly. In the southern Bahamas, green turtles grew from 30 to 75 cm in 17 years, and growth rate decreased with increasing carapace length (Bjorndal and Bolten, 1988). Growth rates measured in green turtles from Florida (Frazer and Ehrhart, 1985), United States Virgin Islands (Boulon and Frazer, 1990) and Puerto Rico (Collazo, Boulon and Tallevast, in prep.) fall within the range of growth rates measured in the southern Bahamas (Bjorndal and Bolten, 1988). Based on growth rate studies of wild green turtles, estimates of age at sexual maturity range from 20 to 50 years (Balazs, 1982; Frazer and Ehrhart, 1985).

Reproduction: Female green turtles emerge at night to deposit eggs; the process takes an average of two hours. Descriptions of the behavioral sequences have been reviewed by Ehrhart (1982). From one to seven clutches are deposited within a breeding season at 12-to-14 day intervals. The average number is usually given as two to three clutches (Carr *et al.*, 1978), but accurate data on the number of clutches deposited per season are difficult to obtain. Mean clutch size is usually 110 to 115 eggs, but this mean varies among populations. Average clutch size reported for Florida was 136 eggs in 130 clutches (Witherington and Ehrhart, 1989). Only occasionally do females produce clutches in successive years. Usually 2, 3, 4, or more years intervene between breeding seasons. Mating occurs in the water off the nesting beaches. Very little is known about the reproductive biology of males, but evidence is accumulating that males may migrate to the nesting beach every year (Balazs, 1983). Hatching success of undisturbed nests is usually high, but on some beaches, predators destroy a high percentage of nests (Stancyk, 1982). Large numbers of nests are also destroyed by inundation and erosion. Temperature dependent sex determination has been demonstrated for green turtles (see review in Standora and Spotila, 1985). Eggs incubated below a pivotal temperature--which may vary among populations--produce primarily males, and eggs incubated above the pivotal temperature produce primarily females. Reviews of the reproductive biology of green turtles can be found in Hirth (1980b), Ehrhart (1982) and Bjorndal and Carr (1989).

Movements: The navigation feats of the green turtle are well known, but poorly understood. We know that hatchlings and adult females on the nesting beach orient toward the ocean using photic cues (Ehrenfeld, 1968; Mrosovsky and Kingsmill, 1985). We do not know what cues are employed in pelagic-stage movements, in movements among foraging grounds, or in migrations between foraging grounds and nesting beach. Because green turtles feed in marine pastures in quiet, low-energy areas and nest on high-energy beaches, their feeding and nesting habitats are, of necessity, located some distance apart. Green turtles that nest on Ascension Island forage along the coast of Brazil, some 1,000 km away (Carr, 1975). The location of the foraging grounds of green turtles that nest in Florida is not known. It has been generally accepted, but not proven, that green turtles return to nest on their natal beach. Green turtles do exhibit strong site-fidelity in successive nesting seasons. Meylan (1982) has reviewed information of turtle movements based on turtle tag returns.

Threats - Nesting Environment

Beach Erosion: Erosion of nesting beaches can result in partial or total loss of suitable nesting habitat. Erosion rates are influenced by dynamic coastal processes, including sea level rise. Man's interference with these natural processes through coastal development and associated activities has resulted in accelerated erosion rates and interruption of natural shoreline migration.

Beach Armoring: Where beachfront development occurs, the site is often fortified to protect the property from erosion. Virtually all shoreline engineering is carried out to save structures, not dry sandy beaches, and ultimately results in environmental damage. One type of shoreline engineering, collectively referred to as beach armoring, includes sea walls, rock revetments, riprap, sandbag installations, groins and jetties. Approximately 20 percent (240 km) of Florida's coast has been armored (FDNR, unpubl. data). Beach armoring can result in permanent loss of a dry nesting beach through accelerated erosion and prevention of natural beach/dune accretion and can prevent or hamper nesting females from accessing suitable nesting sites. Clutches deposited seaward of these structures may be inundated at high tide or washed out entirely by increased wave action near the base of these structures. As these structures fail and break apart they spread debris on the beach which may further impede access to suitable nesting sites (resulting in higher incidences of false crawls) and trap hatchlings and nesting turtles. Sandbags are particularly susceptible to rapid failure and result in extensive debris on nesting beaches. Rock revetments, riprap, and sand bags can cause nesting turtles to abandon nesting attempts or to construct improperly sized and shaped egg cavities when inadequate amounts of sand cover these structures.

Groins and jetties are designed to trap sand during transport in longshore currents or to keep sand from flowing into channels in the case of the latter. These structures prevent normal sand transport and accrete beaches on one side of the structure while starving neighboring beaches on the other side thereby resulting in severe beach erosion (Pilkey *et al.*, 1984) and corresponding degradation of suitable nesting habitat.

Drift fences, also commonly called sand fences, are erected to build and stabilize dunes by trapping sand moving along the beach and preventing excessive sand loss. Additionally, these fences can serve to protect dune systems by deterring public access. Constructed of narrowly spaced wooden or plastic slats or plastic fabric, improperly placed drift fences can impede nesting attempts and/or trap emergent hatchlings and nesting females.

Beach Nourishment: Beach nourishment consists of pumping, trucking, or scraping sand onto the beach to rebuild what has been lost to erosion. Beach nourishment can impact turtles through direct burial of nests and by disturbance to nesting turtles if conducted during the nesting season. Sand sources may be dissimilar from native beach sediments and can affect nest site selection, digging behavior, incubation temperature (and hence sex ratios), gas exchange parameters within incubating nests, hydric environment of the nest, hatching success and hatchling emergence success (Mann, 1977; Ackerman, 1980; Mortimer, 1982b; Raymond, 1984a). Beach nourishment can result in severe compaction or concretion of the beach. Trucking of sand onto project beaches may increase the level of compaction.

Significant reductions in nesting success have been documented on severely compacted nourished beaches (Raymond, 1984a). Nelson and Dickerson (1988) evaluated compaction levels at ten renourished east coast Florida beaches and concluded that 50 percent were hard enough to inhibit nest digging, 30 percent were questionable as to whether their hardness affected nest digging, and 20 percent were probably not hard enough to affect nest digging. They further concluded that, in general, beaches nourished from offshore borrow sites are harder than natural beaches, and, while some may soften over time through erosion and accretion of sand, others may remain hard for 10 years or more. Nourished beaches often result in severe escarpments along the mid-beach and can hamper or prevent access to nesting sites. Nourishment projects result in heavy machinery, pipeline, increased human activity, and artificial lighting on the project beach. These activities are normally conducted on a 24-hour basis and can adversely affect nesting and hatching activities. Pipeline and heavy machinery can create barriers to nesting females emerging from the surf and crawling up the beach, causing a higher incidence of false crawls (non-nesting emergences). Increased human activity on the project beach at night may cause further disturbance to nesting females. Artificial lights along the project beach and in the nearshore area of the borrow site may deter nesting females and disorient emergent hatchlings from adjacent non-project beaches.

Beach nourishment projects require continual maintenance (subsequent nourishment) as they erode and hence their negative impacts to turtles are repeated on a regular basis. Beach nourishment projects conducted during the nesting season can result in the loss of some nests which may be inadvertently missed (or misidentified as false crawls) during daily patrols conducted to identify and relocate nests deposited on the project beach (Lund, 1973; R. Wolf, pers. comm.,)

Nourishment of highly eroded beaches (especially those with a complete absence of dry beach) can be beneficial to nesting turtles if conducted properly. Careful consideration and advance planning and coordination must be carried out to ensure timing, methodology, and sand sources are compatible with nesting and hatching activities.

Artificial Lighting: Extensive research has demonstrated that the principal component of the sea-finding behavior of emergent hatchlings is a visual response to light (Daniel and Smith, 1947; Hendrickson, 1958; Carr and Ogren, 1960; Ehrenfeld and Carr, 1967; Dickerson and Nelson, 1989; Witherington, 1989). Artificial beachfront lighting from buildings, streetlights, dune crossovers, vehicles and other types of beachfront lights have been documented in the disorientation (loss of bearings) and misorientation (incorrect bearing) of hatchling turtles (McFarlane, 1963; Philibosian, 1976; Mann, 1977; 1980; Ehrhart, 1983).

The results of misorientation are often fatal. As hatchlings head toward lights or meander along the beach their exposure to predators and likelihood of desiccation is greatly increased. Misoriented hatchlings can become entrapped in vegetation or debris, and many hatchlings are found dead on nearby roadways and in parking lots after being struck by vehicles. Hatchlings that successfully find the water may be misoriented after entering the surf zone or while in nearshore waters. Intense artificial lighting can even draw hatchlings back out of the surf (Daniel and Smith, 1947; Carr and Ogren, 1960). During 1988 alone, 10,155 misoriented hatchlings were reported to the FDNR. An unquantifiable number of additional disorientation and misorientation events undoubtedly occurred but were not documented due to depredation, entrapment in thick vegetation, loss in storm drains, or obliteration of carcasses by vehicle tires.

The problem of artificial beachfront lighting is not restricted to hatchlings. Carr *et al* (1978), Mortimer (1982b), and Witherington (1986) found that adult green turtles avoided bright areas on nesting beaches. Problem lights may not be restricted to those placed directly on or in close proximity to nesting beaches. The background glow associated with intensive inland lighting, such as that emanating from nearby large metropolitan areas, may deter nesting females and misorient hatchlings navigating the nearshore waters. Cumulatively, along the heavily developed beaches of the southeastern United States, the negative effects of artificial lights are profound.

Beach Cleaning: Beach cleaning refers to the removal of both abiotic and biotic debris from developed beaches. There are several methods employed including mechanical raking, hand raking and hand picking up of debris. Mechanical raking can result in heavy machinery repeatedly traversing nests and potentially compacting sand above nests and also results in tire ruts along the beach which may hinder or trap emergent hatchlings. Mann (1977) suggested that mortality within nests may increase when externally applied pressure from beach cleaning machinery is common on soft beaches with large grain sands. Mechanically pulled rakes and hand rakes can penetrate the surface and disturb the sealed nest or may actually uncover pre-emergent hatchlings near the surface of the nest. In some areas collected debris is buried directly on the beach, and this can lead to excavation and destruction of incubating egg clutches. Disposal of debris near the dune line or on the high beach can cover incubating egg clutches and subsequently hinder and entrap emergent hatchlings and may alter natural nest temperatures. In some areas, mechanical beach cleaning is the sole reason for extensive nest relocation.

Increased Human Presence: Residential and tourist use of developed (and developing) nesting beaches can result in negative impacts to nesting turtles, incubating egg clutches, and hatchlings. The most serious threat caused by increased human presence on the beach is the disturbance to nesting females. Night-time human activity can cause nesting females to abort nesting attempts at all stages of the behavioral process. Murphy (1985) reported that disturbance can cause turtles to shift their nesting beaches, delay egg laying and select poor nesting sites. Heavy utilization of nesting beaches by humans (pedestrian traffic) may result in lowered hatchling emergence success rates due to compaction of sand above nests (Mann, 1977), and pedestrian tracks can interfere with the ability of hatchlings to reach the ocean (Hosier *et al.*, 1981). Campfires and the use of flashlights on nesting beaches misorient hatchlings and can deter nesting females (Mortimer, 1979).

Recreational Beach Equipment: The placement of physical obstacles (e.g., lounge chairs, cabanas, umbrellas, hobie cats, canoes, small boats, beach cycles) on nesting beaches can hamper or deter nesting attempts and interfere with incubating egg clutches and the sea approach of hatchlings. The documentation of false crawls at these obstacles is becoming increasingly common as more recreational beach equipment is left in place nightly on nesting beaches. Additionally, there are documented reports of nesting females becoming entrapped under heavy wooden lounge chairs and cabanas on south Florida nesting beaches (J. Hoover, pers. comm., S. Bass, pers. comm). The placement of recreational beach equipment directly above incubating egg clutches may hamper hatchlings during emergence and can destroy eggs through direct invasion of the nest (C. LeBuff, pers. comm.).

Beach Vehicular Driving: The operation of motor vehicles on nesting beaches for recreational purposes is permitted in northeast Florida (portions of Nassau, Duval, St. John's, Flagler and Volusia counties), northwest Florida (Walton and Gulf Counties), and North Carolina (Emerald Isle, Cape Lookout National Seashore, Cape Hatteras National Seashore and Currituck Banks). While some areas restrict night driving, others permit it. Driving on beaches at night during the nesting season can disrupt the nesting process and result in aborted nesting attempts. The negative impact on nesting females in the surf zone may be particularly severe. Vehicle headlights can disorient or misorient emergent hatchlings and vehicles can strike and kill hatchlings attempting to reach the ocean. The tracks or ruts left by vehicles traversing the beach interfere with the ability of hatchlings to reach the ocean. The extended period of travel required to negotiate tire tracks and ruts may increase the susceptibility of hatchlings to stress and depredation during transit to the ocean (Hosier *et al.*, 1981; M. Evans, FDNR, pers. comm.). Driving directly above incubating egg clutches can cause sand compaction which may decrease nest success and directly kill pre-emergent hatchlings (Mann, 1977). In many areas, beach vehicular driving is the sole cause for nest relocation. Additionally, vehicle traffic on nesting beaches contributes to erosion, especially during high tides or on narrow beaches where driving is concentrated on the high beach and foredune.

Exotic Dune and Beach Vegetation: Non-native vegetation has invaded many coastal areas and often outcompetes native species such as sea oats, railroad vine, sea grape, dune panic grass and pennywort. The invasion of less stabilizing vegetation can lead to increased erosion and degradation of suitable nesting habitat. Exotic vegetation may also form impenetrable root mats which can prevent proper nest cavity excavation, invade and desiccate eggs or trap hatchlings. The Australian pine (*Casuarina equisetifolia*) is particularly detrimental. Dense stands of this species have taken over many coastal strand areas throughout central and south Florida. Australian pines cause excessive shading of the beach which would not otherwise occur. Studies in Florida suggest that nests laid in these shaded areas are subjected to lower incubation temperatures which may alter the natural hatchling sex ratio (Marcus and Maley, 1987; Schmelz and Mezich, 1988). Fallen Australian pines limit access to suitable nest sites and can entrap nesting females. Davis and Whiting (1977) reported that nesting activity declined in Everglades National Park where dense stands of Australian pine took over native beach berm vegetation on a remote nesting beach. Conversely, along highly developed beaches, nesting may be concentrated in areas where dense stands of Australian pines create a barrier to intense beachfront and beach vicinity lighting (S. Bass, pers. comm.).

Nest Depredation: A variety of natural and introduced predators such as raccoons, feral hogs, foxes, ghost crabs and ants prey on incubating eggs and hatchling sea turtles. The principal predator is the raccoon (*Procyon lotor)*. Raccoons are particularly destructive and may take up to 96 percent of all nests deposited on a beach (Davis and Whiting, 1977; Hopkins and Murphy, 1980; Stancyk *et al.*, 1980; Talbert *et al.*, 1980; Schroeder, 1981; Labisky *et al.*, 1986). Prior to hog control efforts, up to 45 percent of all sea turtle nests deposited at the Cape Canaveral Air Force Station, Florida, were depredated by feral hogs (FDNR, unpubl. data). In addition to the destruction of eggs, certain predators may take considerable numbers of hatchlings just prior to or upon emergence from the sand.

Nest Loss to Abiotic Factors: Nest loss due to erosion or inundation and accretion of sand above incubating nests appear to be the principal abiotic factors which may negatively affect incubating egg clutches. While these factors are often widely perceived as contributing significantly to nest mortality or lowered hatching success, few quantitative studies have been conducted (Mortimer, 1989). Studies on a relatively undisturbed nesting beach by Witherington (1986) indicated that excepting a late season severe storm event, erosion and inundation played a relatively minor role in destruction of incubating nests. Inundation of nests and accretion of sand above incubating nests as a result of a late season storm played a major role in destroying nests from which hatchlings had not yet emerged. Severe storm events (e.g., tropical storms, hurricanes) may result in significant nest loss, but these events are typically aperiodic rather than annual occurrences. In the southeastern United States, severe storm events are generally experienced after the peak of the hatching season and hence would not be expected to affect the majority of incubating nests. Erosion and inundation of nests is exacerbated through coastal development and shoreline engineering. These threats are discussed above under beach armoring.

Poaching: In the United States, take of nesting female green turtles is infrequent. However, in a number of areas, egg poaching and clandestine markets for eggs are not uncommon. During the period 1983 - 1989 the Florida Marine Patrol made 29 arrests for illegal possession of turtle eggs (figure not apportioned by species).

Threats - Marine Environment

Oil and Gas Exploration, Development and Transportation: Experimental and field results reported by Vargo *et al.* (1986) indicate that marine turtles would be at substantial risk if they encountered an oil spill or large amounts of tar in the environment. Physiological experiments indicate that the respiration, skin, some aspects of blood chemistry and composition, and salt gland function of marine turtles are significantly affected (Vargo *et al.*, 1986). Spills in the vicinity of nesting beaches are of special concern and could place nesting adults, incubating egg clutches (Fritts and McGehee, 1989) and hatchlings at significant risk. Exploration and oil development on live bottom areas may disrupt foraging grounds by smothering benthic organisms with sediments and drilling muds (Coston-Clements and Hoss, 1983). Oil and tar are also released into the marine environment during pumping of bilges on large vessels. In a review of available information on debris ingestion, Balazs (1985) reported that tar balls were the second most prevalent type of abiotic debris ingested by marine turtles.

Dredging: The effects of dredging are evidenced through direct destruction or degradation of habitat and incidental take of marine turtles. Channelization of inshore and nearshore habitat and the disposal of dredged material in the marine environment can destroy or disrupt resting or foraging grounds (including grass beds and coral reefs) and may affect nesting distribution through the alteration of physical features in the marine environment (Hopkins and Murphy, 1980). Hopper dredges are responsible for incidental take and mortality of marine turtles during dredging operations. During a 3-month period in 1980 in the Port Canaveral, Florida, channel, dredging operations were responsible for the mortality of approximately 100 turtles. These high levels of incidental take have not been documented during dredging operations in subsequent years. Maintenance dredging of the Kings Bay, Georgia, channel during 1987-1988 resulted in the mortality of approximately 20 turtles during a 1 year period. Other types of dredges (clamshell and pipeline) have not been implicated in incidental take.

Marina and Dock Development: The development of marinas and private or commercial docks in inshore waters can negatively impact turtles through destruction or degradation of foraging habitat. Additionally, this type of development leads to increased boat and vessel traffic which may result in higher incidences of propeller- and collision-related mortality. Fueling facilities at marinas can result in the discharge of oil and gas into sensitive estuarine habitat.

Pollution: The effects of pollutants resulting from industrial, agricultural or residential sources are difficult to evaluate. Pesticides, heavy metals and PCB's have been detected in turtles (including eggs), but levels which result in adverse effects have not been quantified (Nelson, 1988).

Seagrass Bed Degradation: Boating activities in areas of seagrass beds can result in damage through anchoring and propeller scarring. In the United States Virgin Islands, seagrasses recovered only minimally in areas damaged by anchoring even after a period of seven months (Williams, 1988), and a decline in seagrass distribution was documented over a 30-year period in selected bays. The loss of available foraging habitat resulted in a lowered carrying capacity for specific bays (Williams, 1988). Extensive die-offs of seagrass beds in Florida Bay have recently been reported, and this may have serious consequences for the green turtles which forage there. The cause(s) of that decline have not yet been identified.

Trawl Fisheries: Of all commercial and recreational fisheries conducted in the United States, shrimp trawling is the most damaging to the recovery of marine turtles. The estimated number of green turtles captured annually is approximately 925 of which approximately 225 die (T. Henwood, pers. comm.). Incidental capture and drowning in shrimp trawls is believed to be the largest single source of mortality on juvenile through adult stage marine turtles in the southeastern United States. The majority of these turtles are juveniles and subadults, the age/size classes most critical to the stability and recovery of marine turtle populations (Crouse *et al.*, 1987). Quantitative estimates of turtle take by shrimp trawlers in inshore waters have not been developed, but the level of trawling effort expended in inshore waters along with increasing documentation of the utilization of inshore habitat by green turtles suggest that capture and mortality may be significant. Trawlers targeting species other than shrimp tend to use larger nets than shrimp trawlers and probably also take sea turtles, although capture levels have not been developed. These fisheries include, but are not limited to, bluefish, croaker, flounder, calico scallops, blue crab, and whelk. Of these, the bluefish, croaker, and flounder trawl fisheries likely pose the most serious threats (T. Henwood, pers. comm).

Purse Seine Fisheries: Several purse seine fisheries operate in Gulf of Mexico and Atlantic, including those targeting menhaden and sardines. Turtles may be taken in these fisheries, but the level of take and percent mortality is currently unquantified.

Hook and Line Fisheries: Several thousand commercial vessels are engaged in hook and line fisheries which target various species including coastal species, reef fish, and pelagic species. In addition to commercial take, the recreational fishery is extensive. Turtle captures on hook and line gear are not uncommon, but the level of take and percent mortality are unknown. It is assumed that most turtles are released alive, although ingested hooks and entanglement in associated monofilament/steel line have been documented as the probable cause of death in some stranded turtles.

Gill Net Fisheries: Gill nets are utilized both in inshore and offshore areas for various species and may be stationary or drifting. Mesh size is dependent on the size of the fish which are targeted but the gear is considered non-selective in the species impacted (T. Henwood, pers. comm.). Trammel nets are modified gill nets set in panels of webbing of variable mesh size. Marine turtles are vulnerable to entanglement and drowning in gill and trammel nets, especially when this gear is left unattended. Turtle mortalities resulting from the use of gill nets set for sturgeon in South Carolina and North Carolina have been documented (Ulrich, 1978; Crouse, 1982). In response to this documented take, the state of South Carolina has prohibited gill netting for sturgeon since 1986. Of particular concern are the gill net and trammel net fisheries off the Florida east-central coast. These fisheries, primarily targeting king mackerel, pompano, and shark have undergone recent expansion in the number of vessels and level of fishing effort (Schaefer *et al.*, 1987). Stranding patterns of turtles in this area indicate that significant numbers of turtles may be killed incidental to these fisheries. This may be particularly detrimental to the juvenile green turtle population(s) inhabiting this coastal area.

Pound Net Fisheries: Pound nets are fished extensively in the inshore bays and sounds of North Carolina, Virginia, New York, and Rhode Island. In Virginia, pound nets have been identified as a leading cause of marine turtle mortality (Lutcavage and Musick, 1985). Mortality was principally caused by entanglement and drowning in the leader portion of the gear and was dependent on mesh size, net location, and environmental parameters. In North Carolina, most pound nets have leads constructed of small mesh (5-8"). Results of preliminary investigations indicate that mortality in these nets may be infrequent (Epperly and Veishlow, 1989). Similarly, in New York, most turtles are released alive from pound nets and entanglement in leaders appears infrequent (V. Burke, pers. comm.).

Longline Fisheries: Longline fisheries have increased dramatically over the past several years. Species targeted in these fisheries include tuna, shark, and swordfish. Witzell (1987) estimated that 330 turtles were incidentally captured in the Gulf of Mexico and Atlantic by the Japanese tuna longline fleet during 1978-1981. Due to increased effort and expansion of longline fisheries in recent years, it is believed that longline fisheries may be exerting a major negative impact on marine turtle recovery (T. Henwood, pers. comm.).

Trap Fisheries: Traps are commonly used in the capture of crabs, lobster, and reef fish. Traps vary in size and configuration but all are attached to a surface float by means of a line leading to the trap. Turtles can become entangled in trap lines below the surface of the water and subsequently drown. In other instances, stranded turtles have been recovered entangled in trap line with the trap in tow. The impact of this gear on green turtle populations has not been quantified.

Boat Collisions: Propeller and collision injuries to marine turtles from boats and ships are not uncommon. In 1986, 1987, and 1988, respectively 5.8 percent (111), 7.3 percent (175), and 9.0 percent (179) of all stranded turtles reported in the United States Gulf of Mexico and Atlantic were documented as having sustained some type of propeller or collision injuries, although it is unknown what percentage of these injuries were post-mortem versus ante-mortem (Schroeder and Warner, 1988; Teas and Martinez, 1989). These types of injuries are recorded at higher frequencies in areas where recreational boating and vessel traffic is intense, such as south Florida, the Florida Keys and United States Virgin Islands.

Power Plant Entrapment: The entrainment and entrapment of turtles in saltwater cooling intake systems of coastal power plants has been documented in New Jersey, North Carolina, Florida, and Texas (Roithmayr and Henwood, 1982; Ernest *et al;* 1989; S. Manzella, pers. comm; T. Henson, pers. comm.; R. Schoelkopf, pers. comm.). Average annual incidental capture rates for most coastal plants from which captures have been reported amount to several turtles per plant per year. One notable exception is the St. Lucie nuclear power plant located on Hutchinson Island, Florida. During a 13-year period of operation (March 1976 - December 1988), 1,929 turtles of all species have been removed from the intake canal. The mortality rate is approximately 7.0 percent (Applied Biology, Inc., unpubl. data). Most captures have been loggerheads, though green turtles are not uncommon.

Underwater Explosions: The use of underwater explosives for the removal of abandoned oil platforms, military activities, and oil exploration can injure or kill turtles and may destroy or degrade habitat. During a 3-year period (1986-1988) observers reported one injured (or dead) turtle during the removal of 103 offshore oil structures in the Gulf of Mexico. Of eight turtles deliberately exposed to underwater explosions at distances varying between 229 m and 915 m from the detonation site, five were rendered unconscious (Klima *et al;* 1989).

Offshore Artificial Lighting: The effects of offshore lighted structures on the orientation of hatchling turtles is not completely understood. These lights may attract hatchlings and interfere with proper offshore orientation, and may make them more susceptible to predation (deSilva, 1982).

Entanglement: Turtles are affected to an unknown but potentially significant degree by entanglement in persistent marine debris, including discarded or lost fishing gear (Balazs, 1985). Green turtles have been found entangled in a wide variety of materials including steel and monofilament line, synthetic and natural rope, plastic onion sacks and discarded plastic netting materials (Balazs, 1985; Plotkin and Amos, 1988). Monofilament line appears to be the principal source of entanglement for green turtles in U.S. waters. Records from Florida and the United States Virgin Islands indicate that some entanglement results from netting and monofilament line which has accumulated on both artificial and natural reefs. These areas are often heavily fished, resulting in snagging of hooks and discarding of lines. Turtles foraging and/or resting in these areas can become entangled and drown (FDNR, unpubl. data). The alignment of persistent marine debris along convergences, rips, and driftlines and the concentration of young sea turtles along these fronts increases the likelihood of entanglement at this life history stage (Carr, 1987).

Ingestion of Marine Debris: Marine turtles have been found to ingest a wide variety of abiotic debris items such as plastic bags, raw plastic pellets, plastic and styrofoam pieces, tar balls and balloons. Effects of debris ingestion can include direct obstruction of the gut, absorption of toxic byproducts and reduced absorption of nutrients across the gut wall (Balazs, 1985). Studies conducted by Lutz (in press) revealed that both loggerhead and green turtles actively ingested small pieces of latex and plastic sheeting. Physiological data indicated a possible interference in energy metabolism or gut function, even at low levels of ingestion. Persistence of the material in the gut lasted from a few days to 4 months (Lutz, in press). Of particular concern is the co-occurrence of persistent marine debris and the early life history pelagic stages of green turtles along convergences. Young turtles are dependent upon these driftlines for their food supply, and hence the likelihood of debris ingestion is increased (Carr, 1987). While quantitative data on population effects are undetermined, the impacts of debris ingestion are considered serious.

Poaching: Illegal directed harvesting of juvenile and adult green turtles in the waters of the continental United States and U.S. Caribbean is not uncommon, but no estimates of the level of take exist. During the period 1983-1989, the Florida Marine Patrol made three arrests for illegal possession of whole turtles and 25 arrests for illegal possession of turtle parts within Florida (figures are not apportioned by species). Illegal take of green turtles in the United States Caribbean, particularly in Puerto Rican waters, is likely the most significant problem.

Predation: Predation of hatchling and very young turtles is assumed to be significant and predation of subadult through adult stage turtles is assumed less common, but valid estimates of mortality due to predation at various life history stages are extremely difficult, if not impossible, to obtain and have not been determined. Hatchlings entering the surf zone and pelagic stage hatchlings may be preyed upon by a wide variety of fish species and to a lesser extent, marine birds. Stancyk (1982) in an extensive literature review reported predators of juvenile and adult turtles to include at least six species of sharks, killer whales, bass, and grouper. Tiger sharks appear to be the principal predator of subadult and adult turtles. While stranded turtles may exhibit shark inflicted injuries, caution must be exercised in attributing a cause of death as these wounds can be inflicted post-mortem.

Diseases and Parasites: There is little information available to assess the comprehensive effects of disease and/or parasites on wild populations of green turtles. The vast majority of diseases and conditions which have been identified or diagnosed in sea turtles are described from captive stock, either turtles in experimental headstart programs or mariculture facilities (Wolke, 1989). One notable exception is the occurrence of fibropapillomas on green turtles, first described by Smith and Coates (1938). Fibropapillomas are now common on immature green turtles in the central Indian River system of Florida, Florida Bay, and in the Florida Keys (Ehrhart *et al.*, 1986; Witherington and Ehrhart, 1987; Schroeder, 1987a). In the central Indian River lagoon, approximately half of all green turtles captured have been found to bear papillomas of varying degree (Ehrhart *et al.*, 1986). Recent reports from Puerto Rico and the United States Virgin Islands indicate a very low occurrence of fibropapillomas on green turtles collected in these areas (R. Boulon and J. Collazo, pers. comm.). Fibropapillomas are also commonly found on Hawaiian green turtles. These tumor like growths can result in reduced vision, disorientation, blindness, physical obstruction to normal swimming and feeding, an apparent increased susceptibility to parasitism by marine leeches, and an increased susceptibility to entanglement in monofilament fishing line (Balazs, 1986). Blood counts and serum profiles of green turtles inflicted with fibropapillomas indicate marked debilitation (Jacobson, 1987).

Conservation Accomplishments - Nesting Environment

Management to mitigate the effects of naturally occurring events such as erosion and vegetation, and a variety of man-induced factors mentioned in the previous section, usually consists of relocating nests to higher sites on the dune, or into a hatchery. This was once a common practice throughout the southeast region. More recently the emphasis of management is to be far less manipulative with the nests and hatchlings. Table 1 contains a listing of most of the major Federal, State and private nest protection projects involving green turtles along the southeast coast.

Table 1. Major green turtle nest survey/protection projects in Florida (1985 - 90)

Project	Beach length (km)	Number of nests/year	*Conservation measure(s)
Canaveral National Seashore	37.0	22-181	S/NS
Merritt Island NWR	9.6	13-55	S/PR
Cape Canaveral Air Force Station	21.0	6-24	S/PR
Patrick Air Force Base	7.0	0-16	S
Melbourne Beach	21.0	66-477	S/PR
Sebastian Inlet State Recreation Area	4.8	7-56	S/PR
Hutchinson Island	36.5	45-132	S
St. Lucie Inlet State Park	3.8	7-17	S/PR
Hobe Sound NWR	5.7	3-30	S/PR
Town of Jupiter Island	12.1	45-228	S
J.D. MacArthur State Park	2.9	9-65	S/PR
City of Boca Raton	5.6	2-43	S/NS/NR
Broward County Beaches	39.0	4-106	S/NR
Dade County Beaches	22.5	3-11	S/NR

* S=Survey
NS=Nest Screening
PR=Predator Removal
NR=Nest Relocation

Perhaps the most frustrating habitat protection effort is trying to minimize or eliminate the construction of seawalls, rock revetments, groins, sand bags and improperly placed drift or sand fences. State and Federal laws designed to protect the beach and dune habitat are: Coastal Barrier Resources Act of 1982 (Federal), and Coastal Zone Protection Act of 1985 (Florida). These have had varying degrees of success at maintaining suitable nesting sites for sea turtles. The Governor and Cabinet of the State of Florida approved a Beach Armoring Policy on December 18, 1990. This policy prohibits armoring along a 20-mile stretch of high density nesting beach between Melbourne Beach and Wabasso Beach and restricts armoring elsewhere to structures threatened by 5-year return interval storm events.

Beach nourishment is a better alternative for sea turtles than seawalls and jetties. When beach nourishment was done mostly in the summer, however, all nests had to be moved from the beach prior to nourishment. Now FWS and State DNR review beach nourishment projects in an effort to exclude nourishment during the nesting and hatching season on important nesting beaches. Beaches where compaction after nourishment is a problem are plowed to a depth of 3-feet to soften the sand so that it is useable for nesting turtles (Nelson and Dickerson, 1987). Progress is being made in the region toward better timing of projects and sand quality.

Progress is also being made by many counties and towns to prevent disorientation and misorientation of hatchlings (Ernest et al., 1987; Shoup and Wolf, 1987). In Florida, lighting ordinances have been passed in Nassau, Flagler, Volusia, Brevard, Indian River, St. Lucie, Martin, Palm Beach, Broward,Collier, Lee, Charlotte and Sarasota Counties. The United States Air Force has developed and is implementing lighting plans for launch complexes and other facilities at Cape Canaveral Air Force Station, Florida, and has established exterior lighting policy for all new construction on the base.

Because of more attention to the status of sea turtles, human take is not the problem it once was on United States beaches, although this is still a major problem in other countries. The isolated cases of nest poaching receive immediate attention from FWS law enforcement and state conservation officers.

In addition to implementing management on nesting beaches, there has been extensive research into the effects of this management on sea turtle populations. Specifically, the most important aspect in recent years is the effect of incubation temperature on the sex ratio of hatchlings reared in styrofoam boxes (Yntema and Mrosovsky, 1980; Morreale *et al.*, 1982; Standora and Spotila, 1985). Use of these boxes has been discontinued as a standard practice.

The status of green turtles is being determined by monitoring the various life stages on the beach to evaluate current and past management practices. This is being done by counting how many nests are laid, how many of these successfully hatch, and the production of hatchlings reaching the ocean. Standardized ground surveys on index beaches are underway throughout Florida by the FWS, State agencies and by private groups and universities. Index beaches include 90 percent of the nesting activity in Florida. Because of slow growth rates and subsequent delayed sexual maturity, all monitoring will need to be conducted over a long period of time to establish population trends.

Conservation Accomplishments - Marine Environment

Managing sea turtles in the water lags behind efforts on the beach due to limited access to turtles, lack of information on habitat usage by different age classes and cost. Therefore, most efforts to preserve marine and estuarine habitats are regulatory in nature.

The USCG has contingency plans for the containment, recovery and minimization of damage from spillages of oil and hazardous substances, as well as major disasters (J. Schmidtman, pers. comm.) But trying to prevent bilge pumping, industrial discharges and chemical and oil spills in the marine environment is a very difficult problem.

In 1978, NMFS implemented a gear development program which would prevent the drowning of turtles in shrimp trawls. The first device was large mesh webbing across the mouth of the net which proved to be ineffective. Subsequently, a cage-like design installed within the trawl, called a turtle excluder device (TED) was developed. Concurrent with the government's action, new designs were built by individual shrimpers. Six types of TEDs have been tested and approved. Lack of widespread use of these devices on a voluntary basis resulted in regulations requiring their use. The final regulations were published in June 1987. After legal, congressional and administrative delays, the regulations went into effect in September 1989. South Carolina promulgated state regulations requiring TEDs in state waters in June 1988. Florida implemented emergency State regulations in February 1989, after unprecedented numbers of strandings the previous fall. Florida also implemented permanent year round regulations in June 1990. The State of Georgia developed TED regulations which went into effect in November 1990.

Annex V of the International Convention for Prevention of Pollution from Ships was ratified by the United States on December 31, 1987 (also known as MARPOL). The Coast Guard published an interim rule in the Federal Register May 30, 1989, implementing provisions of Annex V. This rule will reduce the amount of plastics, including synthetic fishing nets, and other ship-generated garbage intentionally discharged into the marine environment. The rule also requires ports or terminals, including recreational boating facilities, commercial fishing facilities and mineral and oil shore bases, to ensure the availability of facilities to receive ship-generated garbage.

In consultation with the COE, FDNR and the NMFS, modifications of dragheads are being tested to minimize turtle mortality from dredges. Each dredging project undergoes a Section 7 consultation, and most dredges are required to have observers onboard. The timing of the projects is also designed to avoid as many turtle encounters as possible.

Research into different ways of keeping turtles from entering the intake pipes at power plants proved unsuccessful. Turtles that are entrapped at the St. Lucie, Florida, plant are captured, tagged and released.

Netting studies in the Indian River and Mosquito Lagoon, Florida, are providing information on habitat use by juvenile green turtles (Ehrhart, pers. comm.). Distribution, size and species composition is being determined in the inshore waters of North Carolina (Epperly and Veishlow, 1989). Similar studies are also underway in the United States Virgin Islands and Culebra, Puerto Rico (Boulon and Frazer, 1990; Collazo et al., in prep.).

Because of turbid waters near shore, assessing turtle stocks by pelagic aerial survey is probably not feasible. Information on the distribution of sea turtles over the continental shelf has until recently been from casual observations and most were anecdotal. Since 1978, four pelagic surveys in the southeast regions have been completed during which sea turtles were counted (Fritts *et al*; 1983; Thompson and Shoop, 1984; Lohoefener *et al.*, 1988). These flights have provided information on the geographic and seasonal distribution of sea turtles.

Information from vessels is largely opportunistic. It was through incidental capture that the winter hibernaculum for sea turtles in the Canaveral ship channel was discovered (Ogren and McVea, 1982). NMFS is also conducting interviews and netting surveys in the Gulf of Mexico (L. Ogren, pers. comm.).

Catch per unit effort (CPUE) and rates of mortality provide a reasonable estimate of the number of captures and fatalities when used along with fishing effort statistics. These data provide information on seasonal abundance and distribution over wide geographic areas (Henwood, 1987; Henwood and Stuntz, 1987).

A regional, data collection effort was begun in 1980 to monitor mortality. This voluntary network from Maine to Texas is coordinated by the NMFS and serves to document the geographic and seasonal distribution of sea turtle mortality (Schroeder, 1987a,b). Since 1987, four index zones have been systematically surveyed. It is clear that strandings represent an absolute minimum mortality. However, they can be used as an annual index to mortality and are an indication of the size and distribution of turtles being killed. They can also provide valuable biological information on food habits, sexual condition and sex ratios.

Accomplishments - Information and Education

One of the easiest ways to implement good management is to inform and educate the public. Personnel conducting turtle projects often advise tourists on what they can do to minimize disturbance to nesting turtles, protect nests and rescue disoriented hatchlings. Likewise, State and Federal parks which conduct beachwalks provide information to visitors. FDNR has developed guidelines for organized beach walks in order to minimize any disturbance to nesting turtles while still allowing them to be viewed by the public. Some beaches have been posted with signs informing people of the laws protecting sea turtles and providing either a local or a hotline number to report violations.

Private conservation organizations such as the Center for Marine Conservation, Greenpeace, National Audubon Society, and Federal and State agencies have produced and distributed a variety of audio-visual aids and printed material about sea turtles. These include: the brochure "Attention Beach Users," a booklet (Raymond, 1984a) on the various types of light fixtures and ways of screening lights to lessen their effects on hatchlings, "Lights Out" bumper stickers and decals, a coloring book, video tapes, slide/tape programs, full color identification posters of the eight species of sea turtles, and a hawksbill poster. Florida Power and Light Company also has produced a bumper sticker and a booklet (Van Meter, 1990) with general information on sea turtles.

Recent reviews of sea turtle conservation efforts in the southeastern United States appear in Hopkins-Murphy (1988) and Possardt (1991).

PART II. RECOVERY

A. Recovery Objectives

The United States population of green turtles can be considered for delisting if, over a period of 25 years, the following conditions are met:

1. The level of nesting in Florida has increased to an average of 5,000 nests per year for at least 6 years. Nesting data must be based on standardized surveys.

2. At least 25 percent (105 km) of all available nesting beaches (420 km) is in public ownership and encompasses at least 50 percent of the nesting activity.

3. A reduction in stage class mortality is reflected in higher counts of individuals on foraging grounds.

4. All priority one tasks have been successfully implemented.

B. Stepdown Outline and Narrative

1. Protect and manage habitats.

11. Protect and manage nesting habitat.

Coastal development has already destroyed or degraded many miles of nesting habitat in the southeast. Although nesting occurs on over 500 km of beaches, development pressures are so great, cumulative impacts will result in increased degradation or destruction of nesting habitat and eventually lead to a significant population decline if not effectively combated.

111. Ensure beach nourishment projects are compatible with maintaining good quality nesting habitat. (also see 215)

Beach nourishment can improve nesting habitat in areas of severe erosion and is a preferred alternative to beach armoring. The quality of material should be similar to that on local natural beaches.

1111. **Implement and evaluate tilling as a means of softening compacted beaches.**

Poor quality material deposited on nesting beaches can result in compacted beaches. This can result in increased numbers of false crawls and aberrant nests, increased digging times for nesting females and in some cases broken eggs from clutches deposited in too shallow an egg chamber. Where beach compaction exceeds local natural conditions, tilling to a depth of 77-92 cm should be used to soften beaches. The effectiveness of tilling in softening beaches should also be fully evaluated by the Corps of Engineers (COE) to determine the persistence of beach softening, frequency of tilling required, and the best mechanical method for beach softening.

1112. **Evaluate the relationship of sand characteristics (including aragonite) and hatch success, hatchling sex ratios, and nesting behavior.**

Gas diffusion and compaction could be affected by sand grain shape, size and compaction and alter hatch success. Sand color influences temperature and can affect hatchling sex determination. The effect of importing non-native materials such as aragonite to United States beaches for beach nourishment adds additional unknowns which could conceivably affect hatchlings and should be discouraged until fully evaluated.

1113. **Reestablish dunes and native vegetation.**

Dune restoration and revegetation with native plants should be a required component of all renourishment projects. This will enhance beach stability and nesting habitat and require less frequent renourishment activities.

1114. **Evaluate sand transfer systems as alternative to beach nourishment.**

Sand transfer systems can diminish the necessity for frequent beach renourishment and thereby reduce disruption of nesting activities and eliminate sand compaction. The construction and operation of these systems must be carefully evaluated by the COE to ensure important nearshore habitats are not degraded or sea turtles injured or destroyed.

112. **Prevent degradation of nesting habitat from seawalls, revetments, sand bags, sand fences, or other erosion control measures.**

Seawalls, revetments and sand bags have already destroyed or degraded approximately 240 km of nesting habitat along Florida's coast. Beach armoring still occurs, however, either illegally or when specific criteria are met under the December 18, 1990, Beach Armoring Policy. The filling and burial of long plastic bags to protect coastal property is a common practice in Florida and has occurred in other states. These buried bags are hard and exacerbate erosion when uncovered by storm events and prevent nesting when uncovered or buried too close to the sand surface.

1121. Evaluate current laws on beach armoring and strengthen if necessary.

State regulations prohibiting or discouraging some forms of beach armoring now exist in Florida, Georgia, South Carolina and North Carolina. FDNR should review current State regulations related to beach construction and ensure seawalls, revetments, sandbags and other armoring measures contributing to the degradation of nesting habitat are prohibited.

1122. Ensure laws regulating coastal construction and beach armoring are enforced.

Illegal beach armoring occurs and, all too frequently, no effective action is taken by enforcement agencies to ensure the perpetrator removes the material and restores the habitat. Illegal beach armoring can cumulatively cause significant degradation of nesting habitat. FDNR must frequently monitor beaches and maintain strict enforcement when violations are observed.

1123. Ensure failed erosion control structures are removed.

Failed erosion control structures such as uncovered plastic bags or tubes and fragmented concrete or wooden structures degrade nesting habitat and deter nesting activities. FDNR should ensure failed structures are removed from nesting beaches.

1124. Develop standard requirements for sand fence construction.

Sand fences can effectively build dune systems and improve nesting habitat; however, improperly designed sand fences can trap nesting females and hatchlings and prevent access to suitable nesting. FDNR should develop and evaluate sand fencing designs and establish standard requirements for sand fence construction.

113. Acquire or otherwise ensure the long-term protection of key nesting beaches.

1131. Acquire in fee title all undeveloped nesting beaches between Melbourne Beach and Wabasso Beach, Florida.

Approximately 30-35 percent of all green turtle nesting in the southeastern United States occurs along this 33 km stretch of nesting beach. Development and public use threaten the habitat and nesting activities. The FWS and FDNR should acquire a buffer strip in fee title that at least extends from mean high water west to highway AIA to ensure long-term protection of this nesting habitat. Conservation easements should be acquired on developed properties where fee title acquisition is not possible.

1132. Evaluate the status of the important nesting beaches on Hutchinson Island, Florida, and develop a plan for long-term protection.

Approximately 10 percent of green turtle nesting in the southeastern United States occurs along this 33 km long beach. Development is degrading nesting habitat and public use is causing significant disturbance to nesting activities. FDNR and FWS should evaluate the threats and take appropriate measures including acquisition to ensure long-term protection.

114. Remove exotic vegetation and prevent spread to nesting beaches.

Australian pine trees *Casuarina* spp. shade nests and can alter natural hatchling sex ratios. Australian pines also aggressively replace native dune and beach vegetation through shading and chemical inhibition and consequently exacerbate erosion and loss of nesting habitat. Erosion can topple trees and leave exposed roots which can entrap nesting females.

Removal of exotics such as is ongoing at Hobe Sound NWR, Florida, and St. Lucie Inlet State Park, Florida, should continue. FDNR and FWS should identify other important nesting beaches where exotic vegetation is degrading nesting habitat and work with responsible parties to restore natural vegetation.

12. Protect marine habitat.

Available sea turtle habitat has been significantly reduced over the past century. Among the factors contributing to this loss of habitat are coastal development and industrialization, increased commercial and recreational vessel activities, river and estuarine pollution, channelization, offshore oil and gas development, and commercial fishing activities. If present trends continue, the cumulative loss of suitable habitat could reduce the likelihood of recovery of the species.

121. Identify important habitat.

Green turtles are omnivorous foragers during early life stages, shifting to herbivory for the remainder of their subadult and adult lives. They occur most commonly on feeding pastures of seagrasses and/or algae, but small greens can be found over coral reefs, worm reefs and rocky bottom. Small greens and breeding/nesting adults are occasionally taken by trawlers on shrimping grounds and by dredges in navigation channels. To effectively protect the species, research is needed to document habitat requirements of specific age/size/sex classes. NMFS, MMS, COE and appropriate State agencies should fund the necessary studies.

122. Prevent degradation and improve water quality of important turtle habitat.

Coastal development and associated changes in land utilization have led to severe degradation of habitat through contamination and/or loss of food sources in estuarine and marine waters. Declines in water quality resulting from industrial pollution, channel dredging and maintenance, harbor activities, farm runoff, sewage disposal, etc., have rendered large water bodies marginally habitable. The EPA and state environmental regulatory agencies must ensure that established minimum water quality standards are enforced. Land utilization decisions and associated construction projects should be carefully considered by local governments, States, CZM, NMFS, FWS, EPA, COE and other regulatory and permitting agencies.

123. Prevent destruction of habitat from fishing gears and vessel anchoring.

Bottom tending fishing gears can be destructive to a wide variety of habitats. Coral reefs are particularly vulnerable to destruction from roller rig trawling gear because corals may be crushed by the weight of rollers and trawls. Seagrass, sponge, and other live bottom habitats can also be scoured by trawling gear. Anchoring vessels in sensitive habitats may also be destructive. NMFS and appropriate State resource agencies should evaluate the potential loss of habitat from these activities and take appropriate actions to ensure long-term protection of reefs and other important habitats.

124. Prevent destruction of marine habitat from oil and gas activities.

Oil and gas activities may negatively impact sea turtle habitat during exploration, development, production and abandonment phases. Of particular concern are impacts of oil spills, drilling mud disposal, disposal of other toxic materials, pipeline networks associated with oil and gas fields, onshore production facilities, increased vessel traffic, domestic garbage disposal and explosive removal of obsolete platforms. MMS, COE and the oil and gas industry should take appropriate actions to ensure that known sources of pollution and toxic waste disposal are eliminated. Additional precautions are needed to prevent oil spills. A response team to deal with spills should be established.

125. Prevent destruction of habitat from dredging activities.

Channel dredging projects may have greater impacts on habitat than the obvious mechanical destruction of the channel bottom. Channelization can alter natural current patterns and disrupt sediment transportation, and suspended materials from dredging may severely damage adjacent corals and seagrasses. Additionally, disposal of dredged materials in offshore disposal sites usually smothers existing flora and fauna. The COE and EPA should continue to carefully consider the environmental consequences before permitting any new channel dredging projects or designating new offshore disposal sites.

126. Restore important foraging habitats.

Loss of green turtle foraging habitat has become a major problem in the United States Virgin Islands and in many other United States waters. Seagrass beds are relatively fragile habitats requiring low energy and low turbidity waters. Unfortunately, these water characteristics make them sensitive to development. The cumulative loss of seagrass beds in United States waters is staggering, and these trends must be reversed if we hope to maintain viable green turtle populations. NMFS, FWS and State agencies must take action to limit further development in areas with seagrass beds, and additional steps should be taken to restore seagrasses to areas of historical abundance.

2. Protect and manage population.

21. Protect and manage populations on nesting beaches.

Predators, poaching, tidal inundation, artificial lighting and human activities on nesting beaches diminish reproductive success. Monitoring of nesting activities is necessary to implement and evaluate appropriate nest protection measures and determine trends in the nesting population.

211. Monitor trends in nesting activity by means of standardized surveys.

Nesting surveys are undertaken on the majority of nesting beaches. However, prior to the implementation of standardized surveys on index beaches in 1989, beach coverage from year to year varied as did the frequency of surveys, experience and training of surveyors, and data reporting. Consequently, no regionwide determination of nesting population trends was possible with any degree of certainty.

FWS and FDNR should continue to refine standardized nest survey criteria, identify additional index survey beaches to be monitored, continue to conduct training workshops for surveyors, and continue appropriate ground surveys. This is essential to gather a long-term data base on nesting activities which can be used as an index of nesting population trends throughout the nesting range of the species.

212. Evaluate nest success and implement appropriate nest protection measures.

Nest and hatching success on beaches occurring on State or Federal lands and all other important nesting beaches should be evaluated. Appropriate nest protection measures should be implemented by FWS, FDNR and appropriate local governments or organizations to ensure greater than 60 percent hatch rate. In all cases the least manipulative method should be employed to avoid interfering with known or unknown natural biological processes. Artificial incubation should be avoided. Nest protection measures should always enable hatchling release the same night of hatching. Until recovery is ensured, however, projects on all Federal and State lands and key nesting beaches such as Hutchinson Island, Jupiter Island, Juno Beach, and Melbourne Beach, Florida, should strive for a higher rate of hatching success.

213. Determine influence of factors such as tidal inundation and foot traffic on hatching success.

Tidal inundation can diminish hatch success depending on frequency, duration, and developmental stage of embryos. Many nests are relocated due to the perceived threat from tides. The extent to which eggs can tolerate tidal inundation needs to be quantified to enable development of guidelines for nest relocation relative to tidal threats. The effect of foot traffic on hatching success is unknown although many beaches with significant nesting also have high public use. FWS should support research and, in conjunction with FDNR, develop recommendations for nest protection from tidal threat and foot traffic, if appropriate.

214. Reduce effects of artificial lighting on hatchlings and nesting females.

Hatchlings orient primarily to the blue-green wave lengths to find the ocean and consequently many artificial lights disorient and misorient hatchlings, indirectly leading to high hatchling mortality. Recent studies have demonstrated that artificial lights also significantly deter nesting activities.

2141. Determine hatchling orientation mechanisms in the marine environment and assess dispersal patterns from natural (dark) beaches and beaches with high levels of artificial lighting.

While phototropic orientation is the primary hatchling sea finding mechanism, orientation mechanisms in the marine environment need further clarification. If light is the primary determinant, lighting from coastal development could be altering hatchling dispersal patterns on some nesting beaches and lowering survivorship. This could be significant in areas such as Cape Canaveral where lighting from the Kennedy Space Center, Canaveral Air Force Station, Port Canaveral, and Cocoa Beach contribute to a significant background glow. The USAF, KSC and Port Canaveral should support studies to evaluate the impact of lighting on Cape Canaveral hatchling dispersal and survivorship. Other important nesting beaches which may be influenced by coastal lighting should be evaluated by appropriate state resource agencies and coastal communities.

2142. Implement and enforce lighting ordinances.

Where lighting ordinances have been adopted and enforced such as Brevard County, Florida, hatchling disorientation and misorientation have been drastically reduced. All coastal counties and communities with nesting beaches should adopt ordinances May through October. Many incorporated communities within Palm Beach and Broward Counties are particularly problematic because of the high density nesting beaches and the lack of effective lighting regulations.

2143. Evaluate extent of hatchling disorientation on all important regional nesting beaches.

FWS, appropriate state resource agencies, and counties should evaluate hatchling disorientation problems on all important regional nesting beaches. Many lighting ordinance requirements do not become effective until 11 p.m., whereas over 30 percent of hatchling emergence occurs prior to this time. FWS, state resource agencies, and county governments should also support research to gather additional quantitative data on hatchling emergence times and nesting times on representative beaches to support the most effective time requirements for lighting ordinances.

2144. Evaluate need for Federal lighting regulations.

Where local lighting ordinances have not been implemented or are ineffective, Federal regulations should be promulgated under authority of Endangered Species Act on important nesting beaches.

2145. Develop lighting plans at Kennedy Space Center, Port Canaveral, Cape Canaveral Air Force Station and Patrick Air Force Base, Florida.

Launch and support facilities at Canaveral and lighting at Patrick AFB are responsible for hatchling disorientation and misorientation on Merritt Island National Wildlife Refuge and Air Force beaches. Lights from the KSC and USAF facilities may be altering natural hatchling dispersal from Cape Canaveral. The KSC, USAF, and Port should develop light management plans to reduce and eliminate hatchling disorientation and misorientation.

2146. Prosecute individuals or entities responsible for hatchling disorientation or misorientation under the Endangered Species Act or appropriate State laws.

Hatchling disorientation and misorientation from artificial lights can cause high mortality and be the major source of hatchling mortality on some nesting beaches if not controlled. Law enforcement efforts should be focused where lighting ordinances are not being implemented or enforced on major nesting beaches and where flagrant and repeated violations are not addressed.

215. Ensure beach nourishment and coastal construction activities are planned to avoid disruption of nesting and hatching activities.

These activities can cause significant disruption of nesting activities during the nesting season when viewed cumulatively over the nesting range. Nest relocation can involve manipulation of large numbers of nests which can result in lowered hatch success and altered hatchling sex ratios and therefore is not an acceptable alternative to altering the timing of projects. The COE, FWS, and appropriate State agencies should ensure beach nourishment and other beach construction activities are not permitted during the nesting season on local or regionally important nesting beaches.

216. Ensure law enforcement activities eliminate poaching and harassment.

Poaching can be a potentially significant cause of nest loss. FWS should work closely with FDNR to identify problem areas and focus intensive law enforcement efforts to eliminate and deter poaching activities.

217. Determine natural hatchling sex ratios.

It is well documented that incubation temperature determines hatchling sex. Sex ratios of hatchlings on natural beaches throughout the nesting range should be determined over several years in order to evaluate nest relocation programs which could be altering natural sex ratios. FWS and FDNR should support necessary research and evaluate all nest relocation projects to ensure natural sex ratios are not altered. Research should include establishment of temperature transects on the key nesting beaches. To accomplish this, a protocol for standardized temperature monitoring should be developed by FWS and FDNR.

22. Protect and manage populations in the marine environment.

Management and protection of sea turtles in the marine environment is a difficult task. The foremost problem in management and conservation of sea turtles is the lack of basic biological information. To adequately protect and enhance survival of sea turtles, we must know where they occur, in what numbers, at what times, and what factors contribute to mortality. As sources of mortality are identified, steps can be taken to reduce/eliminate their impacts on populations.

221. Determine green turtle distribution, abundance and status in the marine environment.

In efforts to recover threatened or endangered species, it is necessary to ensure the survival of all life stages. In the case of sea turtles which exhibit great longevity, it is important to protect all age classes so that a sufficient number of individuals survive to reach sexual maturity. To effectively enhance survival, the most critical information needed is when, where, and in what abundance turtles may occur over the various stages of their life cycles.

2211. Determine seasonal distribution, abundance, population characteristics, and status in bays, sounds and other important nearshore habitats.

Green turtles occur throughout the tropical and subtropical waters of the United States continental shelf and Caribbean, but little is known about specific habitat requirements or habitat fidelity, seasonal distribution and abundance, movements and growth. Research is needed to identify areas and times of turtle abundance, and to answer basic biological questions about the species. Some important areas that should be studied include, among others: Cedar Key, Florida Bay, Indian/Banana River, inshore waters of all southeastern states and nearshore waters of United States Virgin Islands and Puerto Rico. Knowledge of when and where turtles may occur will allow NMFS to take appropriate steps to protect various life stages. NMFS, FWS, COE, MMS, and other Federal and State agencies should assist in providing needed information.

2212. Determine adult navigation mechanisms, migratory pathways, distribution and movements between nesting seasons.

Nesting migrations and subsequent dispersal of post-nesting females have been studied principally through tagging on nesting beaches. Movements and distributions of adult males, which may or may not migrate with the females, have been studied to a lesser extent.

Female turtles are known to return to nest in the same general areas at 2-,3-, and 4-year intervals throughout their reproductive lives. Mechanisms which allow turtles to navigate over great distances and to exhibit nesting beach fidelity are poorly understood. Research is needed to determine how turtles navigate, and what factors (olfactory, magnetic, visual) could negatively influence this ability. NMFS, COE, MMS, FWS, and other interested State and Federal agencies should fund appropriate research.

2213. Determine present or potential threats to green turtles along migratory routes and on foraging grounds.

Little is known about the foraging grounds of the Florida breeding population of green turtles. However, green turtle foraging populations have supported commercial fisheries in Texas, Cedar Key, and the Indian River. Threats to migrating turtles are virtually unknown, because we have little information on pathways or mechanisms of migration. Before action can be taken to eliminate threats to sea turtles, we must have knowledge of what factors may impinge on the survival of turtle stocks. Research is needed to determine when and where turtles may occur, and what activities in these areas may negatively impact recovery of the species. NMFS, FWS, COE, MMS and other State and Federal agencies should fund needed research.

2214. Determine breeding population origins for U.S. juvenile/subadult populations.

To effectively manage sea turtle stocks and to determine the efficacy of nest protection activities, it would be advantageous to have a means of determining the origin of juvenile and subadult turtles. Such knowledge could be of major importance if progeny from specific nesting beaches exhibit different behavior, movements, foraging ranges, etc., than turtles from other beaches. Such differences could result in high mortalities in some nesting populations, and low mortality rates in other populations. Appropriate Federal and State agencies should fund this research.

2215. Determine growth rates, age of sexual maturity and survivorship rates of hatchlings, juveniles, and adults.

Knowledge of the age at sexual maturity is necessary if managers are to know when nest protection programs can be expected to show results if successful. Extrapolation of growth rate data using growth equations currently provides the best although an indirect method to estimate age at sexual maturity. Growth data can also be used to assess and compare habitat quality. Direct aging methods using annuli in bones or other body parts may ultimately provide a better alternative and needs further research. Data on survivorship rates will be difficult to obtain for most life stages. To the extent that it can be collected, however, it will enable managers to more fully evaluate management strategies utilizing more accurate predictive population models.

222. Monitor and reduce mortality from commercial and recreational fisheries.

Sea turtles are incidentally taken in several commercial and recreational fisheries. For example, an estimated 229 green turtles are killed annually during commercial shrimp fishing activities. Other fisheries known or suspected to incidentally capture turtles include those employing bottom trawls, off-bottom trawls, purse seines, bottom longlines, hook & line, gill nets, traps, haul seines, pound nets, beach seines and surface longlines.

2221. Implement and enforce TED regulations in all United States waters at all times.

Regulations requiring shrimp trawlers greater than 25 feet in length to use TEDs in offshore waters during certain months of the year went into effect on May 1, 1989. Boats less than 25 feet long must either use TEDs or restrict tow times to 90 minutes. On May 1, 1990, inshore regulations went into effect. While these regulations are expected to have a positive impact on survival of the species, certain areas and times of the year have no TED requirement. To provide the maximum protection to sea turtles, NMFS should amend the regulations to require TEDs in all waters at all times, and ensure that all regulations are enforced.

2222. Provide technology transfer for installation and use of TEDs.

Many shrimp fishermen have refused to use TEDs and have made no attempt to learn about them. If improperly installed or adjusted, turtle mortalities and shrimp losses can be expected until nets are properly tuned. NMFS, Sea Grant, and state agencies should assist the industry in technology transfer for installation and use of TEDs. This service by Federal and State agencies should aid in the smooth transition to use of this new equipment, and will ensure adequate protection of turtles.

2223. Maintain the Sea Turtle Stranding and Salvage Network.

Most accessible United States beaches in the Atlantic and Gulf of Mexico are surveyed for stranded sea turtles by volunteer or contract personnel. Through the Sea Turtle Stranding and Salvage Network, stranding data are archived and summarized by the NMFS Miami Laboratory. These data provide an index of sea turtle mortalities, and are thought to be a cost effective means of evaluating the effectiveness of the TED regulations. These data also provide basic biological information on sea turtles and are useful in determining other sources of mortality. NMFS and/or FWS should continue systematic stranding surveys of index areas and support and augment the network. Periodic review of efficacy of surveys should be conducted.

2224. Identify and monitor other fisheries that may be causing significant mortality.

In addition to shrimp trawls, other types of fishing equipment have been implicated in the deaths of sea turtles. Of particular concern are bottom trawling gear, gill nets and longlines. NMFS recently conducted an internal ESA Section 7 consultation on the potential impacts to sea turtles of all types of fishing equipment in the southeast, and recommended that observer coverage be initiated to document take in several fisheries. This observer coverage should be implemented immediately by NMFS or appropriate State resource agencies.

2225. Promulgate regulations to reduce fishery related mortalities.

If any fisheries are found to result in significant take of sea turtles, regulations to protect turtles should be published by NMFS or appropriate State resource agencies.

223. Monitor and reduce mortality from dredging activities.

The COE is congressionally mandated to maintain the United States navigational channels. To ensure that authorized channel depths are sustained, periodic dredging is required. Some types of dredges, particularly the hopper dredge, have been shown to take sea turtles, and on a cumulative basis, this take is believed to be significant.

2231. Monitor turtle mortality on dredges.

Turtle mortalities can be documented by screening the inflows/outflows on a hopper dredge, by observation aboard a clamshell dredge, or by observing the discharge of a pipeline dredge. Presently, NMFS believes that few, if any, turtles are impacted by clamshell or pipeline dredges, but that the hopper dredge is a major problem. NMFS should require observer coverage and appropriate screening on all hopper dredge operations to document take and associated mortality.

2232. Evaluate modifications of dredge dragheads or devices to reduce turtle captures, and incorporate effective modifications or devices into future dredging operations.

Recent COE and NMFS experiments and photography of operating hopper dredges indicate that suction is greatest directly beneath the draghead. This suggests that turtles taken by hopper dredges must be resting on the bottom in the path of the dredge, and that mortalities could be eliminated if turtles could be moved 2 or 3 feet up or to either side. COE and NMFS gear specialists are attempting to design a "turtle deflector device" which will push turtles out of the dredge path. This research should be continued until an effective device is perfected.

2233. Determine seasonality and abundance of sea turtles at dredging localities, and ensure that dredging is restricted to time periods with the least potential for turtle mortality.

Channels requiring maintenance dredging and in which turtles are suspected to reside should be surveyed by the COE or Navy prior to dredging to determine when, where, and how many turtles are present. To minimize the impacts to sea turtles, all dredging activities should be conducted during times of lowest turtle densities.

224. Monitor and prevent adverse impacts from oil and gas activities.

Oil can alter respiration, severely damage skin, interfere with or stop salt gland function and ultimately lead to the death of turtles. Tar balls pose a particularly serious threat to post-hatchlings and small juveniles since tar balls are frequently eaten and accumulate in the same driftlines which these life stages inhabit.

2241. Determine the effects of oil and oil dispersants on all life stages.

Oil spills resulting from blowouts, ruptured pipelines, tanker accidents, etc., could have a major impact on the recovery of listed sea turtles. As evidenced by the recent Exxon catastrophe in Alaska, Federal and industry abilities to respond to a major spill is woefully lacking. Therefore, it is essential that we have knowledge of the effects of oil and oil dispersants on all sea turtle life stages to allow adequate assessment of risks and implementation of contingency plans should a major oil spill occur. MMS, NMFS, FWS and the oil and gas industry should fund appropriate research.

2242. Ensure that impacts to sea turtles are adequately addressed during planning of oil and gas development.

In assessing the potential impacts of oil and gas activities, it is necessary to look beyond the exploration, development, production and abandonment of single wells, and consider the industry as a whole. In the Gulf of Mexico alone, there are 4,500 existing offshore structures and thousands more projected over the next

20 years. These structures are linked by miles of underwater pipelines, and are supported by fleets of vessels and aircraft. Production and storage facilities onshore supply refined products for tanker transport and land transport throughout the country. The chances of isolated accidents, when considering the existing infrastructure, are very high. Additionally, the cumulative impacts of chronic discharges from thousands of independent structures could be significant. Explosive removal of structures during the abandonment phase of these activities has also been identified as a potential source of mortalities to sea turtles. NMFS, MMS, FWS, and the oil and gas industry should take the necessary actions to ensure adequate precautions are taken to avoid impacts to sea turtles.

2243. Determine sea turtle distribution and seasonal use of marine habitats associated with oil and gas development areas.

Oil and gas activities occur over vast areas of the Gulf of Mexico and southern North Atlantic. Recent technological advances have made it possible to conduct exploration and development activities in deeper waters. Despite the continuing offshore movement of the industry, little effort has been expended in determining distribution, abundance and seasonality of various life stages of sea turtles in offshore waters. MMS and NMFS should fund needed research to evaluate the effects of oil and gas activities on the recovery of sea turtles in offshore waters.

225. Reduce impacts from entanglement and ingestion of persistent marine debris.

Ingestion of marine debris and entanglement of marine organisms in discarded nets, monofilament lines and ropes has received considerable attention in recent years. Young, pelagic-stage turtles are particularly vulnerable to ingestion of persistent materials. Additionally, entanglement in nets, ropes and monofilament lines may be a source of mortalities to all life history stages.

2251. Evaluate the extent of entanglement and ingestion of persistent marine debris.

Limited information on the frequency of entanglement and ingestion of marine debris by sea turtles is available. Stranding data and necropsies have provided evidence that some turtle mortalities have resulted from ingestion of debris. Additionally, stranded turtles have been entangled in lost or discarded netting, monofilament lines, and ropes. NMFS, FWS, and EPA should expand efforts to document cases of entanglement and ingestion, the extent of marine debris in United States waters, sources of these contaminants and the impacts of these materials to various life stages of sea turtle populations.

2252. Evaluate the effects of ingestion of persistent marine debris on health and viability of sea turtles.

In addition to mortalities resulting from ingestion of plastics, hydrocarbons or other toxic substances, debilitating non-lethal impacts are possible. Research is needed to evaluate the long-term effects of ingestion of marine debris, particularly with regard to hatchlings during early life stages. These turtles are believed to congregate in areas of debris concentration such as driftlines. NMFS, MMS, and EPA should fund this research.

2253. Determine and implement appropriate measures to reduce or eliminate persistent marine debris in the marine environment.

Marine debris may originate from land or sea, primarily through careless disposal of non-biodegradable refuse. Suspected sources of these materials are large transport vessels pumping bilges and discarding garbage, commercial and recreational fishermen, oil and gas platforms, beachgoers, cruiseliners, etc. To eliminate the problem, the public must be educated about the long-term consequences of using the oceans as a garbage dump. Point sources of pollution must be identified and eliminated by EPA, Coast Guard, State and Federal agencies. Appropriate agencies should vigorously enforce MARPOL regulations. NMFS should promulgate regulations governing abandonment of fishing gear, and impose severe penalties for discarding these materials.

226. Increase law enforcement efforts to reduce poaching in United States waters.

Illegal directed fishing for sea turtles in United States waters is generally not believed to be a major problem (Puerto Rico is a notable exception). However, incidental take and subsequent consumption of turtles may be a larger problem than suspected among some fisheries. NMFS, FWS and State agencies should focus surveillance and increase law enforcement efforts in identified or suspected problem areas such as Puerto Rico.

227. Determine etiology of fibropapillomatosis.

In recent years, an alarming increase of fibropapillomas in green turtles has been observed. As many as 50 percent of juvenile green turtles captured in the Indian River, Florida, are infected, and there are additional reports from the Florida Keys, Puerto Rico, and the United States Virgin Islands. This virus is debilitating, and it may be lethal. A disease of this nature could have profound effects on the survival of this species. NMFS and FWS should fund needed research to determine the etiology of fibropapillomatosis and, if possible, take actions to reduce/eliminate impacts to green turtle stocks. FWS, NMFS and FDNR should also develop a protocol to prevent the spread of the disease by researchers or others who handle green turtles. The protocol should assume a highly infectious agent until determined otherwise.

228. Centralize administration and coordination of tagging programs.

Sea turtle researchers commonly tag turtles encountered during their research projects, and usually maintain independent tagging data bases. The lack of centralization for administering these tagging data bases often results in confusion when tagged turtles are recaptured, and delays in reporting of recaptures to the person originally tagging the turtle. NMFS and FWS should investigate the possibilities of establishing a centralized tagging data base.

2281. Centralize tag series records.

A centralized tag series data base is needed to ensure that recaptured tagged turtles can be promptly reported to persons who initially tagged the animal. The tag series data base would include listings of all tag series that have been placed on sea turtles in the wild including the name and address of the researcher placing these tags on turtles. This would eliminate problems in determining which researcher is using which tag series or types of tags, and would preclude unnecessary delays in reporting of tag returns. NMFS and/or FWS should establish and maintain this data base.

2282. Centralize turtle tagging records.

In addition to the need for a centralization of tag series records, there are advantages in developing a centralized turtle tagging record data base. Such a data base would allow all turtle researchers to trace unfamiliar tag series or types to their source, and also to have immediate access to important biological information collected at the time of original capture. The major disadvantage is that this data base would require frequent editing and updating, and would be costly and somewhat time-consuming to maintain. It would also make it possible for unethical researchers to exploit the work of others, while providing no guarantees that such contributions would be acknowledged. NMFS and FWS should determine whether such a data base can be established and is feasible to maintain.

229. Ensure proper care of sea turtles in captivity.

Green turtles are maintained in captivity for rehabilitation and research. Proper care will ensure the maximum number of rehabilitated turtles can be returned to the wild and a minimum number removed from the wild for research.

2291. Develop standards for care and maintenance including diet, water quality and tank size.

None of these requirements has been scientifically evaluated to determine the best possible captive conditions for green turtles. The FWS and NMFS should support the necessary research to develop these criteria particularly relating to diet. These criteria should be published and required for any permit to hold sea turtles in captivity. FWS, NMFS and appropriate State resource agencies should inspect permitted facilities at least annually for compliance with permit requirements.

2292. Develop manual for treatment of disease and injuries.

FWS and NMFS should determine disease problems associated with captive sea turtles and publish a manual on the diagnosis and treatment of such diseases. This manual should also include treatment for common injuries. This will improve rehabilitative success and captive care of research and display specimens.

2293. Establish catalog for all captive sea turtles to enhance utilization for research and education.

Currently, captive sea turtles are being held at over 50 facilities. The FWS and NMFS should establish a catalog and act as a clearing house to ensure captive specimens are utilized efficiently to diminish the need for removing additional specimens from the wild.

2294. Designate rehabilitation facilities.

FWS and NMFS in coordination with the appropriate state agencies should designate rehabilitation facilities for Atlantic and Gulf Coast states. Designation should be based on availability of veterinary personnel with expertise or experience in reptilian care and the institutions ability to comply with care and maintenance standards developed in step 2291 above. Each facility should be inspected by a team including an NMFS, FWS and appropriate State representative prior to its designation as a rehabilitation facility. Inspections should be conducted at least annually thereafter.

3. Information and education.

Sea turtle conservation requires long-term public support over a large geographic area. The public must be factually informed of the issues particularly when conservation measures conflict with human activities such as commercial fisheries, beach development and public use of nesting beaches. Public education is the foundation upon which a long-term conservation program will succeed or fail.

31. Provide slide programs and information leaflets on sea turtle conservation for general public.

The FWS has developed a bilingual slide tape program on sea turtle conservation. The FWS should keep the program current and available for all public institutions. The FWS and State resource agencies should continually update and supply the public with informational brochures on sea turtle ecology and conservation needs.

32. Develop brochure on recommended lighting modifications or measures to reduce hatchling disorientation and misorientation.

All lighting ordinances require lights be shut off or modified to prevent direct lighting on the nesting beach. However, it is not always clear what types of light, screening or shading work best. The FWS, NMFS and State resource agencies should jointly develop and publish a brochure or booklet with recommended lighting fixtures, lights, shading modifications, and actions that can be taken to reduce or eliminate light pollution of nesting beaches.

33. **Develop public service announcements regarding the sea turtle artificial lighting conflict, and disturbance of nesting activities by public nighttime beach activities.**

A professionally produced public service announcement for radio and TV would provide tremendous support and reinforcement of the many coastal lighting ordinances. It would generate greater support through understanding. The FWS and State resource agencies should develop a high quality public service announcement which could be used throughout the southeast during the nesting season.

34. **Ensure facilities permitted to hold and display captive sea turtles have appropriate informational displays.**

Over 50 facilities are permitted to hold sea turtles for rehabilitation or research. Many are on public display and afford opportunities for public education. Display of accurate information on the basic biology and conservation problems should be a requirement of all permittees. All facilities should be visited by FWS, NMFS and the State permitting agencies to ensure captive sea turtles are being displayed in a way to meet these criteria.

35. **Post information signs at public access points on important nesting beaches.**

Public access points to important nesting beaches provide excellent opportunities to inform the public of necessary precautions for compatible public use on the nesting beach and to develop public support through informational and educational signs. FDNR, FWS and NPS should post such educational and informational signs on the important nesting beaches as appropriate.

4. International cooperation.

41. **Develop international agreements to ensure protection of life stages which occur in foreign waters.**

Foraging grounds for internesting adults, juveniles or subadults are largely unknown. If the Florida population is typical of other nesting populations, however, it is most likely that important foraging habitats occur outside of United States waters. Consequently, protecting the Florida green turtle nesting population cannot be accomplished solely by protecting turtles on the nesting beaches and in United States waters. Once green turtle foraging and developmental habitats are identified, NMFS and FWS should develop cooperative international agreements and programs with appropriate foreign governments.

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III. IMPLEMENTATION SCHEDULE

Priorities in Column 4 of the following Implementation Schedule are assigned as follows:

Priority 1 - An action that must be taken to prevent extinction or to prevent the species from declining irreversibly in the foreseeable future.

Priority 2 - An action that must be taken to prevent a significant decline in species population/habitat quality or some other significant negative impact short of extinction.

Priority 3 - All other actions necessary to provide for full recovery of the species.

GENERAL CATEGORIES FOR IMPLEMENTATION SCHEDULES

Information Gathering - I or R (research)

1. Population status
2. Habitat status
3. Habitat requirements
4. Management techniques
5. Taxonomic studies
6. Demographic studies
7. Propagation
8. Migration
9. Predation
10. Competition
11. Disease
12. Environmental contaminant
13. Reintroduction
14. Other information

Management - M

1. Propagation
2. Reintroduction
3. Habitat maintenance and manipulation
4. Predator and competitor control
5. Depredation control
6. Disease control
7. Other management

Acquisition - A

1. Lease
2. Easement
3. Management agreement
4. Exchange
5. Withdrawal
6. Fee title
7. Other

Other - O

1. Information and education
2. Law enforcement
3. Regulations
4. Administration

IMPLEMENTATION SCHEDULE

Green Turtle (Recovery Priority#2C)

General Category	Plan Task	Task Number	Priority	Task Duration	Responsible Agency	Estimated Fiscal Year Costs $000 Current	Fy 2	Fy 3	Fy 4	Fy 5	Comments/ Notes
M-2	Implement and evaluate beach tilling	1111	3	continuing	COE						No estimate; costs to be borne by specific nourishment projects
R-3	Evaluate sand character- istics relative to hatch success and nesting behavior	1112	2	4 years	COE		35	35	35	35	
M-3	Re-establish dunes and native vegetation on beach nourishment projects	1113	2	continuing	COE						No estimate; costs to be borne by specific nourishment projects
M-3	Evaluate sand transfer systems	1114	3	continuing	COE						Routine
O-3, M-3	Evaluate current laws on beach armoring	1121	1	continuing	FDNR						Routine
O-3, M-3	Enforce laws regulating coastal construction	1122	1	continuing	FDNR, VIDPNR, PRDNR						Routine
M-3	Ensure failed erosion control measures are removed	1123	2	continuing	FDNR						Routine
M-3	Develop standard require- ments for sand fence construction	1124	3	1 year	FDNR FWS						Routine

IMPLEMENTATION SCHEDULE

Green Turtle (Recovery Priority#2C)

General Category	Plan Task	Task Number	Priority	Task Duration	Responsible Agency	Estimated Fiscal Year Costs $000 Current	FY 2	FY 3	FY 4	FY 5	Comments/ Notes
M-3, A-2 A-3, A-6	Acquire nesting beaches between Melbourne and Wabasso Beach, FL	1131	1	5 years	FWS FDNR	2 M 10 M	15 M 10 M	10 M 10 M	10 M 10 M	10 M 5 M	Total estimated costs of acquisition = 90M; Same as loggerhead task 114 costs not additive
M-3, A-2, A-3, A-6	Evaluate status of Hutchinson Island, FL and develop long-term protection plan	1132	2	2 years	FDNR FWS						Costs will be associated with acquisition if identified in protection plan; recommendations by 1-91 Same as loggerhead task 115, costs not additive
M-3	Remove exotic vegetation at Hobe Sound NWR, FL, St. Lucie State Park, FL and other important nesting beaches	114	3	continuing	FWS FDNR	5 5	5 10	5 10	5 10	5 10	Same as loggerhead task 117, costs not additive
R-2, R-3	Identify important marine foraging habitat	121	2	10-15 years	NMFS, FDNR, NCDNR, GDNR, TPW, ADNR, LDWF, VMRC SCWMRD, MDW						Funds are identified under 2211 because of research overlap with population studies
M-3, O-3	Prevent degradation/ improve water quality of important marine habitat	122	2	continuing	NMFS, EPA, COE, FWS, CZM, coastal resource agencies						Routine
M-3, O-3	Prevent habitat degradation from fishing gear and vessel anchoring	123	3	continuing	NMFS, coastal resource agencies						Routine
M-3	Prevent habitat destruction from oil and gas activities	124	3	continuing	MMS, COE, NMFS						Routine

IMPLEMENTATION SCHEDULE

Green Turtle (Recovery Priority#2C)

General Category	Plan Task	Task Number	Priority	Task Duration	Responsible Agency	Estimated Fiscal Year Costs $000 Current	FY 2	FY 3	FY 4	Fy 5	Comments/ Notes
M-3	Prevent habitat destruction from dredging	125	3	continuing	COE, NMFS						Routine
M-3	Restore important foraging habitat	126	2	continuing	NMFS, COE, FWS						No estimate; recommendations by 1-93
I-1	Monitor trends in nesting activity	211	1	continuing	FWS	100	100	100	100	100	Costs include activities in 212 and 2144
					FDNR	100	100	100	100	100	
					USAF	50	50	50	50	50	
					NPS	60	60	60	60	60	
					FPL	50	50	50	50	50	
					PRDNR, VIDFW						No estimate
					Dade Co., FL						No estimate
					Jupiter Isl., FL						No estimate
					Boca Raton, FL						No estimate
					Juno, FL						Same as loggerhead task 211, costs not additive
I-1, M-4	Evaluate nest success and implement nest protection measures	212	1	continuing	same as 211						Costs included in 211; Same as loggerhead task 212, costs not additive
R-14, M-7	Determine influence of tidal inundation and foot traffic on hatch success	213	3	4 years	FWS		20	20			
					FDNR				20	20	Loggerhead will serve as model; costs not additive to loggerhead task 213
R-14, M-7	Determine hatchling orientation mechanisms; assess dispersal patterns	2141	2	2 years	USAF		110				
					KSC			75			Same as loggerhead task 2142, costs not additive
					CPA			25			
M-7, O-3	Implement and enforce lighting ordinances	2142	2	continuing	FL east coast counties and cities from Port Canaveral south to Miami Beach						No estimate

IMPLEMENTATION SCHEDULE

Green Turtle (Recovery Priority#2C)

General Category	Plan Task	Task Number	Priority	Task Duration	Responsible Agency	Estimated Fiscal Year Costs $000 Current	FY 2	FY 3	FY 4	Fy 5	Comments/ Notes
I-14, M-7	Evaluate extent of hatchling disorientation on important regional nesting beaches	2143	3	continuing	FWS FDNR, and FL coastal counties and cities						Costs included in 211
O-3	Evaluate need for Federal lighting regulations	2144	3	continuing	FWS						Routine
M-7	Develop lighting plans for Cape Canaveral, FL and Patrick AFB, FL	2145	2	4 years	USAF KSC CPA						No estimate; complete in FY 91 No estimate; complete in FY 92 No estimate; complete in FY 93
O-2	Prosecute parties responsible for hatchling disorientation	2146	3	continuing	FWS NMFS						Routine
O-2	Ensure coastal construction activities avoid disruption of nesting/hatchling activities	215	3	continuing	COE FDNR FWS PRDNR VIDPNR						Routine
O-2	Ensure law enforcement activities minimize poaching and harassment on nesting beaches	216	3	continuing	FWS FDNR						Routine
R-14	Determine natural hatchling sex ratios	217	3	10 years	FWS FDNR						Costs included in 211

IMPLEMENTATION SCHEDULE

Green Turtle (Recovery Priority#2C)

General Category	Plan Task	Task Number	Priority	Task Duration	Responsible Agency	Estimated Fiscal Year Costs $000 Current	FY 2	FY 3	FY 4	Fy 5	Comments/ Notes
R-1	Determine seasonal distribution, abundance, pop. characteristics status in inshore and nearshore waters	2211	1	15-20 years years	NMFS, MMS, COE, FWS, FDNR, TPW, GDNR, PRDNR, SCWMRD, NCDNR, VIDPNR		2 M	2 M	2 M	2 M	Same as loggerhead task 2211, costs are not additive
R-3, R-8, R-14, M-7	Determine adult navigation mechanisms, migratory pathways, distribution and movements	2212	2	5 years	NMFS FWS MMS COE				250	250	Total cost for all agencies
R-1, M-7	Determine threats along migratory routes and on foraging grounds	2213	2	continuing	NMFS FWS COE MMS						No estimate
R-14, M-7	Determine breeding population origins for U.S. juvenile/subadult populations	2214	2	5 years	NMFS FWS State resource agencies		150	150	150	150	
R-1, R-6	Determine growth rates, age at sexual maturity, survivorship rates	2215	2	continuing	NMFS, FWS, State resource agencies		200	200	200	200	Other costs associated with 2211; same as loggerhead task 2215; costs are not additive
O-2, O-3 M-7	Implement and enforce TED regulations	2221	1	continuing	NMFS State Marine Fisheries						Routine
O-3	Provide technology transfer for installation and use of TEDS	2222	3	continuing	NMFS State sea grant agencies						Routine

IMPLEMENTATION SCHEDULE

Green Turtle (Recovery Priority#2C)

General Category	Plan Task	Task Number	Priority	Task Duration	Responsible Agency	Estimated Fiscal Year Costs $000 Current	FY 2	FY 3	FY 4	Fy 5	Comments/ Notes
I-1, I-14	Maintain sea turtle stranding network	2223	2	continuing	NMFS FWS coastal state resource agencies	100	100	100	100	100	Same as loggerhead task 2223, costs are not additive
I-1, I-14, M-7	Monitor other fisheries causing mortality	2224	2	continuing	NMFS State Marine Fisheries Commissions		100	100	100		
O-3, M-7	Promulgate regulations to reduce fishery related mortality	2225	2	3 years	NMFS State Marine Fisheries Commissions						Routine
I-14, M-7	Monitor turtle mortality on dredges	2231	3	continuing	COE NMFS						No estimate; COE responsible for costs and NMFS for oversight
I-14, M-7	Evaluate modifications of dredge dragheads or devices to reduce turtle captures	2232	3	continuing	COE NMFS						No estimate; COE responsible for costs
I-1, M-7	Determine seasonality and abundance of turtles at dredging localities	2233	3	continuing	COE USN NMFS						No estimate; COE responsible for costs; costs included in estimates in 2211
R-14	Determine effects of oil and dispersants on all life stages	2241	2	continuing	MMS industry						No estimate, MMS and industry responsible for costs
O-4, M-7	Ensure impacts are addressed during planning of oil and gas development	2242	3	continuing	MMS COE NMFS industry						Routine

IMPLEMENTATION SCHEDULE

Green Turtle (Recovery Priority#2C)

General Category	Plan Task	Task Number	Priority	Task Duration	Responsible Agency	Estimated Fiscal Year Costs $000 Current	FY 2	FY 3	FY 4	Fy 5	Comments/ Notes
R-1, M-7	Determine sea turtle distribution and seasonal use of marine habitats associated with oil and gas development	2243	3	3-5 years	MMS COE NMFS						Costs included in estimates in 2211
R-1, R-12	Evaluate extent of entanglement/ingestion of persistent marine debris	2251	2	10 years	NMFS EPA	30	100	100	100	100	Same as loggerhead task 2251, costs not additive
R-12	Evaluate effects of ingestion of persistent marine debris on health and viability	2252	2	5 years	NMFS EPA		50	50	50	50	
M-7, O-2, O-3	Implement measures to reduce or eliminate persistent marine debris	2253	2	continuing	EPA USCG State environmental agencies						No estimate
O-2	Increase law enforcement efforts to reduce poaching in U.S. waters	226	2	continuing	NMFS FWS		100	100	100	100	Additional LE manpower is needed in Puerto Rico
R-11	Assess mortality and determine etiology of fibropapillomatosis	227	1	5-10 years	NMFS FWS FDNR	10	500	500	600	400	
I-14, O-4	Centralize tag series records	2281	3	1 year	NMFS FWS						Routine; FY 91

IMPLEMENTATION SCHEDULE

Green Turtle (Recovery Priority#2C)

General Category	Plan Task	Task Number	Priority	Task Duration	Responsible Agency	Estimated Fiscal Year Costs $000 Current	FY 2	FY 3	FY 4	Fy 5	Comments/ Notes
I-14, O-4	Centralize turtle tagging records	2282	3		NMFS FWS						Estimated costs 50K annually; same as loggerhead task 2272, costs not additive
R-14, M-7 O-3	Develop standards for care and maintenance of captive sea turtles	2291	3		NMFS FWS			20	20	20	
R-11, M-6	Develop manual for treatment of disease	2292	3	1 year	NMFS FWS			15			
M-7	Establish catalog for all captive sea turtles	2293	3	continuing	NMFS FWS						Routine
M-7	Designate rehabilitation facilities	2294	3	continuing	NMFS FWS						Routine
O-1	Provide slide programs/ information leaflets	31	3	continuing	FWS NMFS State resource agencies						Routine
O-1, M-7	Develop brochure on recommended lighting modifications	32	3	1 year	FWS NMFS						Routine
O-1, M-7	Develop PSA on artificial light problem	33	3	1 year	FWS FDNR		10 10				same as loggerhead task 33, costs not additive
O-1	Ensure permitted facilities display turtles with educational displays	34	3	continuing	FWS NMFS State resource agencies						Routine

IMPLEMENTATION SCHEDULE

Green Turtle (Recovery Priority#2C)

General Category	Plan Task	Task Number	Priority	Task Duration	Responsible Agency	Estimated Fiscal Year Costs $000 Current	FY 2	FY 3	FY 4	Fy 5	Comments/ Notes
O-1, M-7	Post educational/informational signs on important nesting beaches	35	3	continuing	FDNR FWS						Routine
M-7, O-8	Develop international agreements	41	2	continuing	FWS NMFS						Routine